Transcript of Proceedings

Conference on Survival Rations, Chicago, 1945
at
QMC Subsistence Research & Development Laboratory
on
20 August 1945

Note: All the material in this transcript has been approved by the conferees.

ATTENDANCE LIST

Conference on Survival Rations
QMC - SR&DL
20 August 1945

Army Air Forces

Major Charles U. Culmer
Major J. S. Butts
Major P. F. Scholander
Captain Charles Carveth
Captain H. S. Wilgus
Captain S. A. D'Angelo
Lt. W. Fosdick, Liaison Office, SR&DL
Lt. F. G. Sherman
Miss Patricia Taylor

Army Ground Forces

Lt. Col. John J. Dolan
Lt. Col. Oliver G. Kinney
Major K. J. Hatke

Office of The Quartermaster General

Captain W. R. Junk
Dr. Samuel Lepkovsky
Mr. James W. Boyer
Mr. Robert G. Biesel
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Navy Department

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Lt. Comdr. R. E. Silver, Liaison Office, SR&DL
Lt. M. C. Shelesnyak
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Coast Guard

Dr. Paul A. Neal

Armored Medical Research Laboratory

Major William B. Bean

Office of The Surgeon General

Major W. F. Ashe, Jr.
Major G. H. Berryman, Medical Nutrition Laboratory

Physiologists

Dr. Herbert E. Longenecker
Dr. David Schwimmer
Dr. Austin Henschel
Dr. A. C. Ivy
Dr. Edward M. Scott

QMC Subsistence Res. & Dev. Laboratory

Colonel R. A. Isker
Major V. O. Wodicka
Captain L. M. Richardson
Captain L. G. Voss
Lt. R. Couch
Lt. R. P. McDevitt
Dr. Franklin Dove
Dr. Gertrude Gottschall

Colonel Isker:

The survival ration is just as important now as it was during the War. The Navy, Coast Guard, and Maritime Services are still on the high seas. The Army Air Forces expects to continue operations on a worthwhile scale while commercial aviation will operate on a much larger scale.

This Laboratory has been working on the survival ration as set up by the Army Air Forces, however, there seems to be very little difference between the requirements for the Air Forces and for the other Services of the Army. The requirements as set up for the survival ration are as follows: (a) high caloric density, (b) palatable, (c) usable with a limited supply of water, (d) usable for survivors who are wounded or suffering from shock, (e) packaged in a manner so that it will be easy for a man to carry as well as for life boat and plane stowage. With these requirements in mind, an all purpose survival ration can be developed in place of the several that are now in existence.

This Laboratory has taken the following steps in developing such a ration: (a) published a survey of needs (copies furnished to conferees) (b) called this conference to discuss the problem and possibly get other ideas and expend opinions on what the ration will take, (c) and will follow up this conference with further research, i.e., testing of foods to determine acceptability for men that are suffering from dehydration, the effects of various foods on men who live on a limited caloric intake and limited water supply. Further research of this kind will probably affect many of the present rations.

What will a man eat under a nervous strain and when he is more interested in "looking after his own hide"? Also, which foods are best for him?

The K Ration was to serve as an assault as well as a combat ration. (The K Ration did not prove satisfactory as an assault ration). The C Ration was to be used as a combat ration. The 10-in-1 Ration, which is actually a D Ration, was to be used in the early stages of invasion. Due to pressure on other developments, very little has been done toward a survival ration.

World War I was stable warfare--trench warfare--and it was fairly easy to bring cooked foods to front line troops. In World War II--mobile warfare--most of the action was away from the kitchens and therefore made it extremely difficult to bring food to moving troops. Research must be kept up to keep abreast of the developments of warfare and to supply foods which will keep the soldier fit under all circumstances of warfare. Research is important to keep a nation prepared. The nation best prepared is the least likely to be attacked and if that nation is attacked, they will be the most likely to win. Now that war is drawing to a close we hope you will continue to give us the wholehearted cooperation you have given us up to this time.

Colonel Isker suggested the formation of some sort of organization of the group of conferees to keep abreast of new developments and to pattern foods for developments and changes that take place.

Captain Wilgus:

At the present time the AAF uses two survival rations, the Life Raft Ration for sea survival and the Parachute Emergency Ration for land survival. Distinction should be made between a survival item and a rescue item.

Survival items are intended to be carried in the airplane at all times in case of an emergency. The pay load of bombs, ammunition and personnel and the required fuel are at a maximum. Hence space and weight limitations restrict the amount of survival items that can be carried. Various survival items are now being packed in order of priority in the accessory kits of life rafts. First priority is given to signalling devices, such as flares and radar reflectors, that will aid in locating survivors after the emergency. Second priority is for first aid equipment. Third priority is for water and water catchment equipment. Food and food catchment equipment, such as fishing tackle, take last priority. There is no provision in survival kits for protective clothing and shelter. These are carried as separate items or supplied by rescue aircraft.

Rescue items are intended to be delivered to located survivors, ordinarily by means of a rescue airplane. The primary cargo is rescue equipment. Hence, limitations are not placed on what may be carried. Regular Quartermaster Rations and even hot meals may be supplied.

Probably the first limiting factor determining the type of food to be carried for survival purposes is the most severe condition under which it would be used. Arctic conditions could furnish as severe a test as any that might be encountered. Should an airplane have to be ditched in this region and should the crew manage to get on a life raft with the ordinary survival equipment, they might last no longer than 48 hours. Immediate protection from the elements is essential to survival, hence food would be of relatively low importance. But, given adequate protection from the elements in the form of protective clothing in a covered life raft, food would assume an important role in survival as a means of maintaining body temperature, strength and morale. Under Arctic or winter conditions on land or sea, prompt rescue or at least a supply of adequate, suitable equipment by rescue airplanes assumes primary importance. The rescue airplanes should carry an adequate amount of food. Arctic trials have demonstrated that the 10-in-1 Ration may provide the main source of such food and that it might well be supplemented with certain high caloric sustenance items.

Under more temperate conditions the chances for prolonged survival are somewhat greater since the elements are less severe. Provisions for prompt rescue are not as urgent. Therefore, survival times may be longer and some source of food might have an important bearing on the length of of survival time.

The Parachute Emergency Ration is intended for land conditions where crews bail out over land or are forced to make a crashed landing. Two cans

of such rations, each containing about 1050 calories, may be readily accommodated in the Emergency Sustenance Vest, Type C-1. This ration consists primarily of sweet chocolate and the cheese and cracker bar. It is intended more or less to give survivors some nourishment during the first day or so while they are recovering from the initial shock and are establishing local sources of food. During the first 24 hours survivors usually are in a condition of mental confusion and the knowledge that they have some food with them undoubtedly has a morale value. Under most land conditions there should ordinarily be a local source of water. Therefore, only water purification tablets are supplied. This is expected to suffice except in desert areas where the prerequisite for survival is to get rescued within a very few days since the only source of water is what is actually carried in the airplane and is therefore exceedingly limited.

The Life Raft Ration is intended for sea survival, under which conditions there is ordinarily a limited supply of water. The amount of water available obviously determines the nature of the ration. Up to very recently, water on life rafts was from a limited number of Emergency Drinking Water cans, each providing 11-1/2 ounces of water, plus any rain water that could be caught in a tarpaulin and stored in plastic water bags. More recently a Sea Water Desalting Kit has been developed and has come into general use. This kit consists of six desaulting briquets and a treatment bag. The kit packs in the same volume as the Emergency Drinking Water can but will yield 5-1/2 pints of potable water or approximately 7-1/2 times as much water as the can. One of these kits is supplied in the individual life raft and six kits are packed in the multiplace life rafts. At the present time, a practical solar still is going into production and a very few of these have been distributed. The solar still is very compact, packing into approximately 60 cu. inches when deflated. Three stills are packed in a Sea Water Distillation Kit. Two of these kits are placed in the accessory kit of the multiplace raft in addition to the six Sea Water Desalting Kits and one can of Emergency Drinking Water. No provisions have yet been made for packing a solar still in a one-man life raft. Each still will produce up to 1-3/4 quarts of water under the most favorable conditions, that is, a long day of sunshine. It will produce some water even on moderately overcast days. The distilled water ordinarily is contaminated with a small trace of salt water. On the average it is estimated that some one to four grams of salt may be thus supplied per day. This has physiological significance. Under Arctic conditions the stills might be inoperable because extreme cold renders the structural material very brittle. However, a relatively large amount of water could ordinarily be obtained from snow and ice. Dr. Fetcher of the Personal Equipment Laboratory has carefully studied climatic conditions on the main oceans of the world and has estimated that the amount of water from non-expendable sources, that is, from the solar stills and from rain source, would yield approximately one quart of water per man per day as a reasonable expectation. Under the very worst conditions the amount of water might be down to one pint.

The present Life Raft Ration was designed for use before the advent of

solar stills and sea water desalting kits. It therefore consists of sugar candy on the basis that pure carbohydrate requires the least water in metabolism. The amount of this ration provided is limited by the required amount of space in the life raft accessory kits. Thus, no food is provided in the one-man life raft. The survivor must depend on what food he may carry in the C-1 Vest if he has one. At the present time, a man on the one-man life raft is in a tight spot for numerous reasons. In multiplace rafts there are seven cans of Life Raft Ration supplying a total of approximately 15,000 calories. This is figured to supply six men about 360 calories per man per day for seven days. These seven cans pack to about 306 cubic inches in space although originally 400 cubic inches were allotted. Rather than to arbitrarily assign a given amount of space for a certain number of calories per man for so many days, it would be better to ascertain what composition of food and how many calories per man per day would best serve the purpose when about one quart of water per man per day is available. This should be the starting point of investigations on the universal Survival Ration.

Recently the possible use of plankton as a survival food from the sea has been brought to the attention of this Laboratory by Dr. Alexander Bajkov. He has demonstrated that a plankton net can be used as a sea anchor on the raft as well as to catch these small organisms under certain conditions. Significant quantities of plankton may thus be caught and are evidently fairly palatable. Fresh plankton, squeezed partially free of adhering sea water, contains about 10% dry matter, of which approximately 60% is protein, 10-20% is fat and up to 15% is ash. Salt concentration is about 1/3 to 1/2 that of sea water. Plankton is distributed rather generally throughout the oceans of the world in sufficient quantities to be a potential source of food. It may thus be an emergency source when all others fail. Much work remains before plankton can be advocated safely as a survival food. Such studies are being initiated at ATSC. It seems possible with the limited amount of food on the life raft, the survivor may be able to live on plankton and/or fish after the survival ration is consumed, providing adequate water is available.

Several questions are pertinent at this time regarding a universal survival ration. How much and what kinds of protein can we put in the ration without seriously increasing water requirements? What are the most acceptable forms of food which can be utilized? The AAF is vitally interested in research to ascertain the minimum levels of caloric intake which will permit utilization of significant amounts of protein for sparing body tissue when water intake is restricted to about one quart per day. It is apparent that such information is essential in order to determine the composition of a universal survival ration. Colonel Isker has indicated the necessity for continuing with this type of research and the AAF heartily concurs with this opinion.

Major Ashe asked Captain Wilgus if there was any data to show that objections have been raised by survivors or by other people to the present Life Raft Ration and Parachute Emergency Ration. Captain Wilgus replied that there was no actual data on this question except that the survivors

apparently have seldom consumed the Life Raft Ration and that objections have come largely from various test subjects.

Lt. R. P. McDevitt stated that the Subsistence Laboratory would be glad to conduct necessary tests on plankton.

Major Culmer:

Procedures in the event of emergency termination of a flight, vary with the type of aircraft involved. Where a normal landing is not possible, the plane may be "ditched" if over water, crash-landed if over land, or the crew may bail out. The choice made by the pilot depends on the circumstances and the type of plane.

In general, transport aircraft are ditched or crash landed. The same is true of most bombardment craft. In fighter planes, on the other hand, it is usually considered better to "bail out" and descend by parachute.

This means there can be no one standard set of conditions. Where the plane is ditched or crash-landed, a fairly large amount of emergency-survival equipment may be salvaged for use by the survivors. The man who has to "bail out" has only those things attached directly to himself or his gear.

The space in the cockpits of fighter-type aircraft is usually very limited. Not much emergency-survival equipment can be "hung" on the pilot if he is still to fly efficiently. In bombers and transport aircraft, on the other hand, much more can be taken along.

It should be remembered that the primary mission of a military combat aircraft is to carry bombs and ammunition to destroy the enemy. Often this takes precedence over other equipment intended for the safety of the crew. Besides, on long missions, much fuel must be carried. Any aeroplane can be burdened with only a certain maximum of weight - otherwise it cannot fly.

The tendency in the military flying has been to add more and more weight of emergency-survival equipment, until in bombers the figure now approaches 90 lbs. per crew man. The commercial air lines, on the other hand - faced with the necessity to operate at a profit (pay load must be high) - are approaching an emergency survival equipment load of only 6 lbs. per person aboard.

The length of time for which survival must be planned will always depend on the quantity and quality of rescue facilities. The planned survival time must be in direct ratio to the expectable time for rescue to take place.

Finally, while in peace time it will always be possible to carry more weight and bulk of emergency-survival equipment, sight must not be lost of the fact that a military air force must always be ready for war. That means being ready to carry a heavy "pay load" of bombs and other instruments of destruction. So we must always aim at small bulk and low weight for emergency-survival equipment.

Lt. McDevitt added that some sort of coordination between plane stowage and the survival equipment would have to be figured out. He also suggested that perhaps a flexible ration could be developed so that part of the ration could come off where there was not enough space, and if there was space, then the whole ration could be carried. Also, if commercial airlines came to ATSC for help and guidance, the Laboratory requested that it be informed of the discussions.

Capt. Carveth:

The fighter pilot has the worst situation and in fixing him up you could fix up other crew members in multi-place aircraft by using various multiples of fighter ration. If we can get a ration to fit the Arctic situation, then it will fit any other situation. Fighters carry more equipment than we are lead to believe. Fighter pilots do not carry rations in their one-man life rafts and must carry food supplies in their sustenance vest, type C-1, para-pack, or jungle kit. However, the fighter pilot finds ways to carry more food as in his flying clothes.

Since March, we have had more than 340 distress incidents. In all these incidents the longest survival period has been for 14 days. In this incident the survivor, the only survivor, out of a B-29 crew, had only two oranges to live on. On the 14th day a Navy airplane dropped him some Navy type, Emergency Life Raft Rations and 2 pints of water. When he was picked up he weighed only 130 pounds, his original weight being 162 pounds. He had no use of his legs when rescued and his seat was rotting. He had fishing tackle but was unsuccessful in catching fish. He got one fish with a spear but spit it up when he tried eating it. Very few men can eat fish in a raw state. He had one and three-quarters quarts of water and was discouraged about catching rain water because of the constant salt splashed on his shield. In another incident, a P-38 pilot paddled 170 miles to rescue himself. He had one chocolate bar and a medical kit, both of which were soggy. In still another case, a fighter pilot who used the Permutit Kit successfully, got a great deal more water from the kit than the instructions indicated possible. He had a life raft, para-pack, knife, pistol and tracer shells, and cloth chart. The chocolate bars were carried in the pockets of his clothing. He was never particularly conscious of hunger. On the fifth day a typhoon hit which caused the loss of his rations and water. He could have caught a small bird but had no particular hunger pains and consequently did not catch it as a source of food. He reported that there was plenty of rain and he could have had all the water he wanted to drink. About the fifth or sixth day, he began to go out of his mind and imagined he was talking to Iwo Jima. When the submarine came to pick him up, he said, "Where have you been, I have been calling and talking to you a long time?" The survivor in this cases walked to his bunk and was all right physically. (This brought up the suggestion to put vitamins and nutrients in medical kits. Capt. Carveth said this was good, except where the kit is not water proofed).

The American pilots have always preferred the small tin of rations because it is not bulky and is easy to carry. Now, flying suits are being designed with large pockets and zippers so that it will be more convenient to carry things on the person.

The basic airplane ration kit should be provided with more substantial food. The Emergency Rescue Survival Ration should provide sufficient food in quality to sustain life in the Arctic. Conditions of survival in the Arctic would be equivalent to the conditions prevailing in the Northern waters of Japan.

In war time, rescue operations must be stepped up a good deal to provide rescue facilities for combat aircraft, which are more apt to require this service. Rescues have been taking place in less than 24 hours and for the most part within five hours. This would seem to close the question of survival rations, but actually the rescue facilities after the war will be curtailed and it might not be possible to make rescues in a matter of hours. Present ATC operations are a good example for bringing out the fact that even where rescue facilities constantly standing by, but not on actual patrol, a survivor may be on the water for some time before he is rescued.

Dr. Ivy commented that if the tactical situation is such that most of the men have to bail out, then the ration should be considered on the basis of the one-man unit.

Capt. Carveth reported that more and more men were being rescued as the result of increased number of bail-outs. As far as transport airplanes are concerned, the plane most always ditched because of its excellent ditching characteristics. Parachutes are not required in ATC Aircraft. This type of plane will float for 30 minutes, which permits sufficient time for the personnel to get out with complete survival equipment.

Dr. Ivy stated that earlier reports indicated that there were not many bail-outs.

Lt. Shelesnyak added that unless a plane is on fire, it is more common to ditch it than to bail out. As for the new jet propelled planes, they are so fast that it might not be possible to ditch, and this will bring on new problems.

(Off-the-record discussion on "340 incidents" which Major Ashe had inquired about.)

Lt. Col. Dolan added that a good ration would be a combination of the "no-good" D Ration and an assault ration. This combination would probably make up an all-purpose ration to fit the amphibious soldier's ration too.

Lt. McDevitt explained that the problem is, what can a man carry for emergency use? Is there a food item that a man could carry that would give him strength under all conditions?

Lt. Col. Kinney commented that it seemed that the pilots are jammed in and carrying a full load. Since they fly in groups, must a man carry his own ration? Can it not be on a special part of the plane with an emergency release for dropping the ration?

Capt. Carveth replied that it is difficult to drop rations closer than 50 yards to survivors on a life raft and 50 yards is a long way when a man might not be physically able to swim after it.

Lt. McDevitt added that anything could happen which might separate a group and therefore would demand individual rations.

Capt. Carveth went on to explain that he did not know of any other specific need for an individual survival ration, except possibly for physical and morale reasons. In one of the reports, a man had to swim 20 minutes to get to his life raft. Rafts are continually being tipped over during storms or high seas, which require the expenditure of energy and strength on the part of the survivor.

Major Culmer added that although, whenever possible, accompanying Aircraft do drop rations and other emergency equipment to a fellow plane which is forced down, this cannot always be relied upon as possible, especially when visibility is poor.

Captain d'Angelo:

Four major points were considered: 1) Tactical Requirements, 2) Questionnaire results, 3) The problem of nutrition as regards the AIR FORCES, 4) Direct physiological effects of food.

Qualified observers (physiologists and flight surgeons) who have returned from various theaters of war all contend that the tactical requirements of getting large fleets of planes in the air and accomplishing their mission are so great that most physiological factors are barely considered. It appears that of these the factor of nutrition is probably more neglected than any of the others. Nevertheless, much evidence indicates that it is quite important.

The AERO-MEDICAL LABORATORY has set up a system of questionnaires by which several thousand combat crew veterans have all ready been interogated regarding various problems. Some of the findings are pertinent to this meeting:

1) Answers vary greatly and include all sorts of "gripes", suggestions as to remedial measures, etc.

2) A substantial number of men in all theaters of operation claimed that better meals both at the base and in the air would have prevented "fatigue" and would have improved morale.

3) Individual choices of food varied greatly, but distinct trends were evident for different theaters of operation.

4) Flying personnel will eat and drink in flight whenever they are hungry and thirsty, regardless of their altitude.

5) Fighter pilots, for the most part, handle the food problem in flight in their own way. They eat pretty much what they want, provided of course, that they can get it.

In our estimation, the problem of nutrition does not begin with a survival ration. So far as a flyer is concerned it begins in the pre-flight stage, continues during flight through to an emergency-should it occur. A man will be better able to meet an emergency if he has adequately been taken care of prior to the new situation. It would be very worthwhile if trained nutritionists could plan and administer to the needs of airmen under combat conditions in the field.

The direct physiological effects of food must be considered. The AERO-MEDICAL LABORATORY has been interested in the problem of fatigue in very long range missions, to which inadequate nutrition may be a contributing factor. To this end an experiment was done in which 6 subjects were exposed to altitudes of 8-10,000 ft. for periods of 10 hours following

a K ration breakfast with no subsequent food. The response to anoxia, and bloodsugar levels were studied. It was found that the K ration, though substantial and not thirst inducing (blood sugar levels, also, were well maintained), had a low order of acceptability. Complaints were vigorous. Some subjects complained about the fruit bar, others objected to the odor of the canned meat and chopped eggs. It was necessary for the observer to remain present to insure consumption of the meal by each subject.

In a similar type of experiment pure carbohydrate was ingested approximately 5 hours after the standard breakfast. It was found that adverse hypoglycemic reactions frequently developed several hours later- a situation hardly desirable in flight, especially should the reactions occur at or about the time of landing. In short, under these conditions a man would be better off with a K ration breakfast alone than he would be with the additional pure carbohydrate.

Two points are thus clearly indicated: 1) a food must be acceptable to flying personnel, otherwise it will not be eaten, 2) it may be unwise to deviate too radically from the normal balance of the proximate principles in designing rations.

Lt. McDevitt exhibited a cereal disc which had caramelized after a 4 month storage period. He pointed out that storing of natural foods in emergency equipment is possible, but this type of ration would have to be replaced at certain time intervals, before storage deterioration. It seemed that even though orders could be issued to change the rations every six month, or whatever time limit would be decided upon, there was the danger of a survivor being confronted with an old ration which had not been changed.

Major Scholander:

(Major Scholander has conducted many experiments on life rafts in different climates.)

The problem of prolonged survival on a life raft in the open sea has become highly actual with the development of the solar still, which, it is believed, will remove the greatest obstacle, namely, water shortage. With adequate protection from exposure, good rations and provision for continuous supply of food by means of fishing equipment, the goal of survival for an almost indefinite period could be reached.

Sea survival in Northern Waters offers especially difficult problems which have not been anywhere nearly solved by the present standard equipment. This is grimly evident in the following statement of Major G. R. Donley, Commanding Officer, 10th AAF Emergency Rescue Boat Squadron, Adak, Aleutians, who is in charge of all air-sea rescue in the Aleutian area.

a. "The following statements are based upon four years of actual experience relative to expected survival time of crashed victims in Aleutian or North Pacific waters:

(1) "Taking into consideration condition of sea and average weather, but regardless of season, it is my conclusion that the life expectancy of an individual in a rubber life raft afloat in North Pacific waters is approximately 48 hours, or less.

(2) "As to continual immersion, an individual is helpless in approximately 30 minutes even though he may be free of injuries and in the best of health prior to immersion."

On a sea survival test in the Aleutians we were given the opportunity to scan the complete four year file of AAF air-sea rescues for that area. Out of 36 crashes in the sea by various types of aircraft, in only 4 instances were survivors picked up. Two of the men, fighter pilots, were brought in alive, in the other two cases only the bodies were found. The following case history was often quoted by the local rescue units as typical for the area: A PBY was forced down in a rough sea. Five survivors were spotted in a rubber life raft by an accompanying PBY. It was presumed that they had abandoned their airplane because of imminent break up of the airplane by wave action. It was further presumed that they boarded the life raft with wholly or partially dry clothing. The water was rough and the occupants of the raft waved the other airplane away when it tried to land. A squall came up preventing further rescue attempts that day. Less than 24 hours later a rescue boat found the raft. Only four men were then aboard and all were dead, frozen stiff from exposure.

The chief reason for the short survival time is death from exposure in the open raft.

Two life raft survival tests were set up from Eglin Field at Attu Island in the Aleutians, in February, 1945, in the same icy waters where prolonged survival with standard equipment had proven impossible.

Two multiplace life rafts were furnished with a watertight tent cover and detachable pneumatic mattress. The raft was tied to the end of a long line which was fastened to the standby boat. Four men occupied the raft. It soon turned out that GI down sleeping bags had to be added to the equipment in order to keep the men warm. Two experiments were done using different rations, but otherwise the same: (1) giving the men standard charms rations and water, (2) giving the men C rations, water and a solid-alcohol stove.

During both of the experiments winds between 20 and 90 miles an hour prevailed, sleet and snow, spray and waves went over the raft continuously. Occupants stayed dry and warm throughout. Each experiment lasted 3 days and 3 nights successively.

Experiments with standard charms ration and water.

The physical strength of the men deteriorated insidiously and rapidly in the course of two days. Third day one man got convulsions and had to be hoisted on board the standby boat with a rope. Everybody was much weakened and in no condition to cope with any emergency situation which only too easily could have occurred in the severe weather.

Lack of thirst and hunger made the men consume only 1/3 of the prescribed candy and 1/10 of the prescribed water. The poor condition of the men already after 2 days must be blamed on the candy rations. In a cold wet area another type of life raft ration must be provided.

Experiment 2.

C Ration, water and solid alcohol stove.

The men were given any amount of C ration and water they wanted during this test. They ate 1/2 of a full C ration and drank 2/3 of a pint of water a day. Fish were caught and a few pounds cooked on the stove. The fish boiled in seawater was highly appreciated. Three times a day we had hot drinks and twice a day heated C ration. Morale was excellent and physical condition preserved well enough to mountain hike when we came out of the raft after three days and three nights of stormy weather.

The equipment permitted survival on the stormy and icy sea without hardship where people with standard equipment would have succumbed.

The situation can be summed up as follow:

In order to make prolonged survival possible in northern waters (and that extends in the winter time at least down to the fortieth latitude) the following conditions must be fulfilled:

1. Airplane must be ditchable.

2. Survival must be based on multiplace rafts provided with cover and air mattress.

3. Extra food C (or K) rations and water must be carried in the plane in addition to the normal amounts of rations (bisquit-pemmican type) and water which can be stored in the life raft accessory bag.

4. Droppable gears (Lindholme or other types) must contain C rations, water and stove. The present standardization on candy in droppable gear is senseless.

Prolonged survival in Northern Waters in a one-man life raft is at the present time impossible. The one-man raft fills up with water all the time and capsizes easily. Sea survival in one-man rafts requires a water-tight exposure suit and a radical improvement of the one-man raft incorporating water-tight cover and self-righting properties. Nothing of the kind exists at the present time and we must therefore not count upon any sea survival in Northern Waters in terms of the standard one-man raft.

There is ample opportunity to study the whole problem of sea survival on the sea, and it is my firm conviction that unless the laboratory people themselves (I am one myself) get out on actual sea survival tests on life rafts in the ocean, including winter nights, we are never going to learn what equipment and rations are required to make prolonged sea survival possible.

Mr. Biesel:

The duty of the Analysis and Test Section in the Office of the Assistant for Product Analysis, Research and Development Branch, is to analyze all available data bearing upon a Quartermaster item and to establish the military necessity for a new item or for continuing a present item. The military necessity having been established, the Analysis and Test Section is further charged with initiating a project which will disclose the military characteristics of a needed item and performance expected of it when produced. The problem of meeting the needs of the Army then becomes the province of a product section. After the product section has produced the needed item, it is then encumbent upon the Analysis and Test Section to test the developed item for performance. Such tests are continuously being made either through controlled tests in the Zone of Interior or reported upon from the theatres. All such reports are evaluated one with the other.

The survival rations in which we are interested today have not reached a calculated ideal. This has not been because of development but rather because of changing points of view in land rescue problems versus sea rescue problems. This war has demonstrated that either the ditched flyer or lost Infantryman is rescued within a matter of hours, or lost, so it is our present conviction that the survival ration should be one which the soldier will carry with him as a part of his personal equipment; more perhaps as a psychological need than as a fully sustaining ration.

Perhaps in the past we have thought in terms of that which is best for the soldier rather than that which will be acceptable and palatable to him when needed. We will undertake to establish the minimum military characteristics of an all purpose survival ration based upon all available research data now in our files and we will seek additional data from the experience of both enemy and Allied armies.

Sir Hubert Wilkins, one of our consultants, whose experiences in survival needs is well known,has urged for the lost soldier a palatable and acceptable subsistence item. In this respect, he as an explorer, refutes the often repeated assertion that pemmican or the like, suitable for seasoned explorers, is the best.

Time is no longer the essence and if the perfect all purpose survival ration may not be discovered this year, or next, it makes little difference; however, it is essential, before our Armed Forces are dispursed, that their accumulated knowledge on this subject be elicited and made available for laboratory research.

It is believed that these conferences should be had at regular intervals. All of us through exchange of information, in the give and take of free discussion, can come up with long sought for determinations and decisions. One of the most important subjects, closely akin to survival, is the problem of furnishing hot food to forward combat positions where troops cannot be resupplied through normal means. We are, however, bound to find a means of providing at least one hot meal to a soldier each day. This subject might be scheduled for an early conference.

The ensuing information was submitted by the Product Analysis Section. R&D Branch of Military Planning Division of OQMG.

SUBJECT: Report of Sir Hubert Wilkins.

TO: SUBSISTENCE SECTION FROM- A SISTANT FOR PRODUCT ANALYSIS Date: 24 Aug 45 Boyer 4463

1. The following comments have been made by the above identified consultant and are referred for consideration of the Laboratory.

2. It may be practicable to package the rectangular biscuits referred to by Sir Hubert in very thin flexible aluminum metal slightly heavier than is used in tooth-paste tubes.

3. Sir Hubert's notes follow:

Use of unpalatable ration unsound for both combat and emergency.

This rules out "Explorer Type" pemmican, Candy.

Starvation for first one or two days unsound, in case of uninjured survivors. Food missed most first day; morale builder needed to overcome shock; energy needed for adjustment to circumstances. Food can be tapered off to minimum second or third day.

Emergency ration not necessarily best if confined to absolute minimum in bulk and weight. If the minimum is very small, a 25% increase in size and weight would probably pay, considering acceptability, palatability and maintenance of condition so as to be ready for early return to duty.

Supplementary food for sea survivors "consist principally of fish". In this regard see Dr. A. Bajkov's report August 1945 on the availability, palatability and nutrition of Plankton.

Dating of rations important.

Need when devising packaging to consider (if rations do not consist entirely of the "Charm" type:)

a. Utensil for adding water to ration

b. Utensil for heating (with solid alcohol in cans) A special stove is required
c. Utensils for eating prepared emergency ration Most castaways have no knives, spoons, etc.
d. Utensils for feeding the incapacitated. (Spoons or tubes.)

Military characteristics as outlined OK.

Emphasize requirement for providing each man with absolutely equal portions even if men are willing to give some of their share to others. This might be accomplished by making large parcels divisible but separate portions preferred.

Monotony of items not really important if food in the first place is usual, palatable and acceptable as to looks and flavor. In civil life there is a monotony of some acceptable items; these are not rejected.

Would prefer a rectangular biscuit-like tablet of meat flavor
Would prefer a rectangular biscuit-like tablet of fat binded
Would prefer a rectangular biscuit-like tablet cereals, w/milk
Would prefer a rectangular biscuit-like tablet dehydrated fruit
Would prefer a rectangular biscuit-like tablet (raisins or apricots)
Would prefer a rectangular biscuit-like tablet of bouillon.

Wafers (biscuits) in each case (each item) to be packaged in heat sealed cellophane and the suitable proportion of each to be overpacked in quantities sutiable for 1 man for 2 days in a metal can; the can thus suitable for the utensil for mixing, heating, or feeding. (The same package would serve for 2 men for two days - 6 men for one meal.)

PERRY RGB

JWB/ml

Lt. Comdr. Futcher:

Presented answers to questions asked of Bureau of Medicine and Surgery in Army Q.M.C. Subsistence Research and Development Laboratory interim report on "Survival Rations: A Critical Review," dated August 1945. All conferees received copy of answers, which included data on rations supplied on the floats and floater nets of ships and on the pneumatic rafts of aircraft. He emphasized that if one is to design a ration for use with a daily allotment of 800 cc. of water daily, one must be sure that the solar stills and rain-collecting devices will function under all conditions, such as in the cold. Captain Scholander stated he collected considerable snow on the raft in the Aleutians.

Research Division, Bureau of Medicine & Surgery, Navy Department.

18 August 1945

ANSWERS TO QUESTIONS ASKED OF BUREAU OF MEDICINE AND SURGERY IN ARMY Q.M.G. SUBSISTENCE RESEARCH AND DEVELOPMENT LABORATORY INTERIM REPORT ON "SURVIVAL RATIONS: A CRITICAL REVIEW", dated August 1945.

Question 1: What has been the utilization of survival rations by the Navy?

Answer 1: Survival rations are used in the Navy on the boats, life floats, and floater nets supplied to surface craft by the Bureau of Ships, and on the pneumatic rafts and droppable kits procured by the Bureau of Aeronautics.

The Bureau of Ships equips combat vessels with a very few boats, using doughnut-shaped floats and also floater nets as rescue gear for the great majority of personnel. Personnel using the floats and nets are completely immersed in water; since Naval vessels usually cruise in groups the rescue gear is designed with the thought that survivors will be rescued by other vessels in their vicinity within a very few hours. The food ration on these rescue craft is at present the "U.S. Navy Emergency Ration for Life Rafts and Boats"; this ration is procured for BuShips by the Bureau of Supplies and Accounts. Sufficient of this ration is supplied to provide each man of the craft's rated capacity with 1041 calories per day for 3 days. Details of the ration follow:

U.S. NAVY EMERGENCY RATION
FOR LIFE BOATS AND LIFE RAFTS

DAILY RATION PER MAN

	Quantity	Calories as			Total Calories
		Protein	Carbo-hydrate	Fat	
Type C Army Biscuit	5	60	410	140	610
Canned Luncheon Meat, Pork	4	72	0	243	315
Malted Milk Tablets (Enriched*)	1	17	77	22	116
Totals	10 oz.	149 14.3%	487 46.8%	405 38.9%	1041

*The enriched malted milk tablets have the following quantities of vitamins added per ounce. Vitamin A - 1,334 U.S.P. Units; Vitamin B_1 (Thiamin) - 84 U.S.P. Units (.25 mg.); Vitamin D - 134 U.S.P. Units; Riboflavin (Vitamin G) - .34 mg.

BuMed has recommended to BuS&A that this ration be replaced by the Tablet Emergency Ration (the candy type ration described below). BuS&A and BuShips are now experimenting with the packaging of such a ration. It is provisionally planned to supply each man with approximately 480 calories a day of the following ration for 3 days:

PROPOSED RATION FOR LIFE BOATS AND LIFE RAFTS
DAILY RATION PER MAN

Tablet	Total grams	Carb. grams	Prot. grams	Fat grams	Calories
Sucrose-citric	44	44			176
Sucrose-lipid-citric	31	23.6		7.4	161
Sucrose-malted milk	35	26	3.5	2.1	143
Totals	110	93.6	3.5	9.5	480

Four chewing gum tablets are supplied in addition.

The Bureau of Aeronautics supplies on its pneumatic life rafts the "U.S. Navy Emergency Ration for Life Rafts"; this has also been called the "Tablet Emergency Ration". Each man of a raft's rated capacity is supplied a total of three 3-7/8 x 2-1/8 x 1-1/8 inch cans each containing the following minimum amount:

Tablet	Total grams	Carb. grams	Prot. grams	Fat grams	Calories
Sucrose-citric acid	20	20			80
Sucrose-lipid-citric	34	25.8		8.2	177
Sucrose-malted milk	27	21.6	2.7	1.6	111
Totals	81	67.4	2.7	9.8	368

In addition, two multi-vitamin tablets and 2 chewing gum tablets are included, plus a cellophane bag to hold unused portions of the ration.

BuAer employs this U.S. Navy Emergency Ration for Life Rafts in special kits designed for dropping to survivors in the water.

The Research Division of BuMed is acquainted with no survival ration procured by the Navy other than the two which have been described above.

Question 2: What have been the reactions of survivors who have used each type of ration provided?

Answer 2: In general, it may be said that reports on the use of Navy survival rations by actual survivors are so few that they can be construed only as representing the personal likes and dislikes of a handful of individuals.

"U.S. Navy Emergency Ration for Life Rafts and Boats" (BuShips):

The few reports available indicate that the biscuits supplied with this ration are almost inedible in the presence of a dry mouth. The malted milk and luncheon meat are liked by some, are distasteful to others. For a laboratory comparison of this ration with a 150 gram butterscotch candy ration on a small group of subjects on an added water intake of 400 cc. per day, see Dr. Allan M. Butler's study described in Progress Report No. 1 under Contract No. OEMcmr 364. Dr. Butler concluded that the butterscotch ration was preferable under the conditions of the experiment.

"U.S. Navy Emergency Ration for Life Rafts" (BuAer):

Comments on use of this ration from survivors are practically non-existant, despite the fact that NavAer Form 1941 (ditching report in use for nearly a year) includes a space for comment on the rations. Whether this fact indicates that the ration is generally acceptable is open to question; the stay in the water of the great majority of Naval aircraft survivors is so brief that no rations are used. (See Table appended after Question 6.)

Question 3: What is the drinking water supply assured to men on Navy rafts, floats, and boats?

Answer 3: On BuShips boats, floats, and floater nets: Approximately 1000 cc. of water per man of rated capacity usually carried in 5 gallon wooden breakers.

On BuAer Pneumatic life rafts the allotment per man is:

	Water cans	Desalting Kits	Rain Sheet Equiv.	5-qt. storage bag	Solar still	Total Assured Water
						cc.
PK-1 Pararaft kit	1	2	Yes	1	0	5370
Multiplace rafts	1	1	Yes	1	0	2850
Projected one man rafts	0	1	Yes	2	1	2520 +
Projected multiplace rafts	0	1	Yes	1	1	2520 +

This table was calculated on the basis that "assured water" included 330 c.c. per can and 2520 c.c. (6 briquets each providing 420 c.c.) per desalting kit; a "+" was allowed for solar stills; no allowance was made for collected rain.

Question 4: What limitations to food stores are imposed by these drinking water supplies.

Answer 4: Present Navy doctrine is to recommend the drinking of no water during the first day of shipwreck, then at least one pint (480 cc.) per day until only about 10 ounces (300 cc.) remain. It has been considered that on an intake of 480 cc. each day men will become slightly dehydrated, or will be on the verge of becoming dehydrated; hence, it has been considered that any ration provided should incur a minimum loss of water in its metabolism. In general, the emphasis has been placed on providing water on rafts at the expense of food; it has seemed desirable to try and provide 50 to 100 grams daily of a high carbohydrate, high fat ration for the "estimated maximum number of days before rescue". This period of days is of course a difficult one to determine. In passing, it should be noted that the advice to drink as much as 480 cc. of water per day and eat 50 to 100 grams of ration is as a rule not followed by the survivors according to reports; he hoards his water particularly.

Question 5: What is the Navy view on the psychological factors relating to sea survival?

Answer 5: It has been considered that the supply of the best available survival gear to aviators makes it more likely that they will

press their combat mission more vigorously, since the presence of excellent gear improves chances of survival should ditching be necessary as a result of combat. As far as the individual ration items are concerned, it is recognized that, other things being equal, it is preferable to supply a survivor with what he considers "real food" rather than "candy". It is also suspected, without experimental backing, that such food as a cracker is more acceptable to a seasick survivor than "candy".

Question 6: In what manner has it been noted that food decreases the effects of cold and exposure?

Answer 6: In Report No. 4 on BuMed Research Project X-127, prepared by the Naval Medical Research Institute, appeared the statement "Nor should it be forgotten that, under conditions of shipwreck in which one is likely to die from exposure to cold in a short time, food may be of more importance than water in prolonging life". This statement was not based on any experimental work. It was inserted merely to suggest that a ration may be of particular benefit under conditions of cold; at that time consideration had been given to removing all solid rations from life rafts to provide space for water. It seems likely that a supply of food will at least be of greater psychological benefit to poorly protected survivors in very cold waters than a supply of water.

TIME ELAPSING BEFORE RESCUE FOLLOWING 716 DITCHINGS OF AIRCRAFT.

The following data were collected from the Air Sea Rescue Report (NavAer 1941 (10-44)) filled out by Naval Air Combat and Intelligence Officers. The reports reviewed cover the ditchings reported for the period of 8 to 12 months ending approximately 1 August 1945. A large number of ditchings are incidental to carrier take-offs and landings. This table was compiled by the Medical Liaison Officer in DCNO(Air), Navy Department.

(a) Total number of ditchings reviewed - - - - - - - - - 716

(b) Number of ditchings in which rescue was effected in less than 12 hours - - - - - - - - - - - - - - - - 633

(c) Number of ditchings in which rescue was effected in 12 to 24 hours - - - - - - - - - - - - - - - - - - - 56

(d) Number of ditchings in which rescue was effected in one to two days - - - - - - - - - - - - - - - - - 7

(e) Number of ditchings in which rescue was effected in two to three days - - - - - - - - - - - - - - - - - - 8

(f) Number of ditchings in which rescue was effected in four days - 3

(g) Number of ditchings in which rescue was effected in five days - 5

(h) Number of ditchings in which rescue was effected in nine days - 1

(i) Number of ditchings in which rescue was effected in eleven days - 1

(j) Number of ditchings in which rescue was effected in fourteen days - 1

(k) Number of ditchings in which rescue was effected in seventeen days - - - - - - - - - - - - - - - - - - - 1

Lt. Comdr. McCay:

I want to go into a few lines that have not been mentioned here today. Regarding experiences of other nations, we should give some thought to that. For instance, the Japanese had an Emergency Ration like tooth paste consisting of chocolate and whiskey. And what is the reason for vodka as a component in the Russian Emergency Ration? It would be a good idea to go into a study of these. Now that the emergency is over, let us go into these things very deeply, rather than in short-term experiments.

In discussing current troubles resulting from rapid decisions, Lt. Comdr. McCay found that after opening tins of the "Charms" Rations, the cellophane wouldn't come off and just stuck to the candy. He therefore suggested looking into the packaging of it. Lt. Comdr. Futcher commented that the ration packages referred to were experimental samples of the Navy Tablet Emergency Ration stored at 150° F., incidental to a "weathering" test performed by the Navy Bureau of Ships upon metal containers. Lt. McDevitt added that there is a powerful difference between a ceiling of 120° and 150°, even during a short-term storage. Lt. Couch agreed with Lt. McDevitt. Lt. Comdr. McCay added that there had been corrosion of some cans. Will we turn to aluminum cans or some other forms of packaging? In regard to a program of correlation of facilities something should be worked out whereby all information will be correlated.

Lt. Comdr. McCay stated that there had been a lot of short-term experiments and he felt that due to insufficient time, some wrong decisions had been made. He suggested coming back to nutrition and research in order to arrive at some profound decisions. He added that there is a tremendous field of work to be done with monkeys, dogs, rats and even if it takes 20 years, he felt sure that we would get so many kinds of answers that any effort and money would be well expended regarding nutrition from the physiological standpoint.

He mentioned the N.M.R.I. in Bethesda with a building housing about 1000 rats, dogs, monkeys as well as analytical laboratories which are being constructed. There are many diverse fields to go into, such as mechanical experimentation and sea sickness remedies. He suggested we work out some way to make the American public aware of our problems. Few are aware of how many genius minds are strewn hither and yon. He then related an incident of sending out to the public a problem and asking them to submit suggestions to which he received so many worthwhile ideas that he advocated doing something along this line in this particular field. He warned the conferees against going into things without enough research and other ideas.

Capt. d'Angelo asked Lt. Comdr. McCay for his opinion on adding halazone tablets, to which Lt. Comdr. Futcher replied that in the first aid kit they are not used, but that the soldier is supplied with these tablets.

Note: Capt. d'Angelo stated that his question related to "hyoscine" tables to prevent sea sickness. According to opinions expressed at the Conference, this is a matter for the medical services of the using agencies.

Lt. Shelesnyak:

The Medical Liaison Section is particularly concerned at the moment with the problem of the future and although Dr. Busch wrote a stimulating article for research, Lt. Shelesnyak stated that he was appalled and distressed by the "dusting off" of military research by saying it should concern itself with polishing weapons. Regardless of the brilliance of some civilian talent, actually when it comes to military problems, the only way to really solve them is to have an intimate acquaintance of these problems. The problems are so widespread that even the military agencies must inform and advise each other as to what is necessary and this is learned only by operating with the groups, so it is essential to make plans to include military organizations (to play a large part) in the research of military problems.

There are problems in commercial airplanes and military airplanes which are essentially the same. We are looking forward to a close association with the commercial aviation field so that both groups can solve their similar problems. Since machines are becoming more complex all the time we will need much more time to consider new developments in the future. An example of this is the new jet plane which will bring on new physiological problems since even in reference to rescue and survival one cannot bail out of it in ordinary fashion nor ditch it, because of its tremendous speed. Also flying in the Sub-Arctic and Polar Arctic is becoming more significant and this will bring on new problems also in environmental medicine.

In order for a man to use what is given to him, he should be given something that is usable. If it is food, it should be acceptable and that includes, taste, palatability, and packaging. Indoctrination and training is also important. Things should be made simple enough in order to get the use of new developments across to the using parties. However, we should not become pin point in our vision and must not let soldiers feel that their entire mission at times is so that they can use the kit or the new masks, etc., which we developed. Lt. Shelesnyak closed with the thought that we need close association between the engineers, flight surgeons, nutritionists, physiologists and all technical people.

Dr. Neal:

Lt. Comdr. Futcher has replied to the questions asked of the Bureau of Medicine and Surgery in the Army Q.M.C. Subsistence Research and Development Laboratory Interim Report on "Survival Rations: A Critical Review," dated August, 1945.

In addition to Lt. Comdr. Futcher's report, I might add that according to "The Proceedings of the Merchant Marine Council, U. S. Coast Guard, May, 1944":

By law, all lifeboats and rafts are now equipped with ten quarts of water per man capacity, which is sufficient for 20 days (at the rate of one pint a day) plus a supply of food, 14 ounces each of chocolate, pemmican, malted milk tablets, and type C ration biscuits per man to last for a similar length of time.

Due to the Coast Guard's interest in air, sea, land survival and rescue, especially in connection with the increase in private and commercial aviation, the Coast Guard would be interested in the information given out today and in the results of further research. Since a tremendous increase of the use of air travel is expected, it is from this standpoint that the Coast Guard desires to be well prepared for any problems which may arise.

Dr. Lepkovsky

The best type of a survival ration is a quick rescue. The ration itself is of secondary importance, because a person has to survive before he has need for food and water to survive. However, if we are going to have a survival ration we should know something about it. Our interest in the life raft ration started because we were interested in knowing whether protein could be incorporated in it without increasing the water requirements. We found before very long that we were not studying protein in the life raft ration. We were not studying the life raft ration at all. Instead we were studying the basic physiology. of reduced caloric intake with limited availability of water.

Little is known about the physiology of reduced caloric intakes. In our studies, we paid special attention to caloric intakes of 400 and 800 calories daily. At various levels of caloric intakes there are different problems. In fasting or 0 caloric intake, the body is unable to utilize body fat efficiently, resulting in a Ketosis which increases the water requirements. Body fat does not seem to be converted to sugar, and glucose seems to be essential in metabolism to suppress the formation of Ketone bodies and to supply the brain with fuel, since the brain apparently does not retilize fat for fuel. To supply the needed glucose in fasting,body proteins are wastefully torn down and partially converted to glucose.

When 400 calories are furnished daily, little or no Ketone bodies are produced and body proteins are spared to the extent they are broken down to supply essential glucose. However, at this level of caloric intake, the animal organism does not seem to be able to retain dietary protein. Any protein fed seems to be metabolized and the water requirements increased by the amount required to excrete the protein decomposition products.

It is important to establish the caloric requirements at which dietary proteins will be efficiently utilized. From animal work, it appears that it enable proteins to be utilized efficiently, at least half of the caloric requirements must be furnished in the diet. Body fat will then supply the rest of the requied calories so that a normal metabolism is apparently maintained with fat as the chief contributuion of the body.

Since it is impossible to supply proteins at low caloric intakes, the only possibility of reducing tissue protein loss would reside in the ability of some amino acid to spare body protein. Methionine proved to be such an amino acid and its ability to spare body tissue carried through to low caloric intakes in experimental animals. This encouraging information needs to be confirmed and tried out with the human subject

In considering the problem of reduced caloric intakes, the specific dynamic action of food should be considered. Any excess heat (specific dynamic action) produced is wasted unless used to maintain the body temperature. In warm climates such excess heat would be wasted. The balance of food items such as proteins, carbohydrates and fats to produce minimum excess heat should be determined at reduced caloric intakes.

The desire for water, at least in animals as measured by the amounts they voluntarily consume, seems to be related to food intake, the greater the food intake, the more water is voluntarily consumed. The effect of food intake on the desire for water in the human should be determined.

Dr. Schwimmer:

Our work has concerned itself primarily with experimentation utilizing human beings as subjects, and the studies have centered about protein metabolism in the presence of limited fluid and caloric intakes. It was assumed that 800 c.c. of water per man per day on a raft could be counted on, and this amount was allowed. The food ration consisted of 100 grams per man per day.

The experiments were carried out in a closed hospital research ward. After pre-feeding on standard 10-in-1 Ration, the subjects were put on the experimental regime, with limited food and fluid. During the actual deprivation periods, the men were not allowed to chew gum, smoke, brush their teeth, shower, shave, or leave the immediate confines of the ward. Records of room temperature, humidity, and barometric pressure were kept. Our problem was to try, in some measure, to approach conditions obtaining on a life raft, although we could not duplicate exposure and temperature variations, nor could we simulate the psychological strain of any man on a real life raft.

Ten Conscientious Objectors were used as experimental subjects when the studies began. They ranged in age from 18 to 37 years, and in weight from 144 to 198 pounds. These men were considered to be in good health. All had passed Army Induction physical examinations before being assigned to C.P.S. camps, and all had been found normal on the complete clinical and laboratory examinations to which we subjected them as a preliminary.

At the beginning of the studies, an attempt was made to "hit the jackpot" on the first try, in the hope that very definitive information might be obtained immediately. Accordingly, the ten subjects were divided into five groups of two men each, and five different diets were tested for a five day period. The diets used were:

1. 100% Carbohydrate (Charms)
2. 90% Carbohydrate, 10% Protein
3. 80% Carbohydrate, 20% Protein
4. 65% Carbohydrate, 10% Protein, 25% Fat
5. 100% Carbohydrate

During the second phase of our work, the deprivation period was extended from five to ten days, and the experimental diets used were:

1. 86% Carbohydrate, 4% Fat, 10% Protein (3 subjects)
2. 90% Carbohydrate, 10% Fat (3 subjects)
3. 78% Carbohydrate, 12% Protein, 10% Fat (4 subjects)

Because of time limitations today, we shall give you just a few of the results obtained:

All the men survived both the five and ten day deprivation periods comparatively well. They were quite clear mentally, but showed evidence of definite emotional lability and irritability. There were obvious signs of weight loss, ranging from five to as high as thirteen pounds after the ten-day period. The men appeared somewhat dehydrated. The greatest rate of weight loss occurred during the first two days of deprivation; this was due primarily to loss of fluid, rather than to loss of tissue substance.

At the given level of daily fluid intake (800 cc.), our studies so far indicate that it is possible safely to give between five and ten grams of protein in a 100 gram ration. The questions arising when increased amounts of protein are administered are these:

If protein is fed, how much of it is retained and utilized by the body tissues, and how much of it is metabolized and excreted in the urine? How do various types of protein (e.g., milk and egg protein) compare in this respect? How well the kidneys handle the products of protein metabolism? What happens if the kidney does not excrete these nitrogenous products?

In answer to the last question, it may be pointed out that the highest figure we encountered for non-protein nitrogen in the blood stream was 66 milligrams per 100 cc., which is definitely elevated, with others not quite so high. In spite of these elevations, it is important to note that in none of the subjects was there any clinical evidence of uremia. Furthermore, the blood levels for non-protein nitrogen returned to normal soon after deprivation ceased.

At first, we paid little attention to electrolyte balance and the possible need for including salt in the ration. However, a peculiar and unexpected clinical problem cropped up during the very first experimental period. Towards the end of the first day and during the second day of deprivation, many of the subjects complained of severe muscular cramps and aches; these finally wore off about the fourth day. Because we had in the past noted similar symptoms in patients with diabetes or with high blood pressure who had been treated with low-salt diets, it appeared possible that our subjects were suffering from salt deficiency. Accordingly, during the next deprivation phase (ten days), one gram of salt was dissolved in each man's daily ration of 800 cc. water. Amazingly enough, no muscular pains or cramps whatsoever were then encountered.

Chemically, too, there was a definite change noted. During the period when no salt was administered, we noted a rapid

drop in values for blood sodium, and a rise in blood potassium. With the addition of salt to the ration, however, these changes in sodium and potassium were definitely less; also, the onset of these changes was delayed. The addition of salt also had a striking effect in preventing sharp drops of serum chloride concentration. These movements of sodium, potassium, and chlorides were highly suggestive of the chemical imbalance known to occur in human beings with a deficiency of secretion of the adrenal cortex.

As mentioned before, the highest content of fat in any of the rations we utilized was 25%. It is worth noting that the subjects eating this ration complained a good deal of nausea and abdominal distension and discomfort. Because the question of ketosis always comes up when fats are fed or when there is starvation, daily examinations were performed on 24-hour urine samples for detone bodies, but none were found present at any time.

An interesting by-product of our investigations concerns itself with the circulation time of the blood. Using the objective fluorescein method (which reflects primarily the circulation in the skin and soft tissues), it was noted in our subjects that, while the arm-to-lip circulation time was relatively unchanged, the arm-to-leg time was definitely prolonged. This finding, we feel, may very well furnish a clue to the prevention of immersion foot, trench foot, and frostbite -- all of which are related, and all of which are prone to occur especially in situations where there is limitation of food or water, or both. It is as yet not clear just what the basic physiological factors are. We are continuing our investigations on this, and feel that other groups might profitably tackle the same problem.

As to future plans and recommendations: At the present time, we are pre-feeding another group of Conscientious Objectors on 10-in-1 Ration and doing control clinical and chemical studies on them. In line with suggestions already made, these men will be given an experimental ration of 200 grams daily (providing 800 to 900 calories), so that we may evaluate the effect of higher caloric level. We also propose to make a comparison of the relative value of egg protein as against milk protein. Methionine studies are already in progress elsewhere. We shall also study closely the question of what part the adrenal gland plays under such conditions of deprivation as we employ.

We are standardizing our deprivation periods at ten days, since we have found the five-day period is too brief to permit following out of trends to any definitive point. Also, it is proposed to use no less than five subjects on each experimental regime, in order to minimize individual variations.

Lt. Comdr. Futcher asked Dr. Schwimmer if the reason for the subjects' looking dehydrated could be from lack of water. Dr. Schwimmer answered that he did not know whether 800 cc. was enough to prevent completely the appearance of any signs of water loss, and that it was not enough to maintain an absolutely normal water balance. Dr. Lepkovsky added that 800 cc. was not enough, because, when they receive that amount, the subjects' excretions of water are low, indicating that they were dehydrated. Then Lt. Comdr. Futcher brought out the point that if 800 cc. is not enough, it is something to think about. (At this point, Dr. Schwimmer stated that, for all practical purposes, the term dehydration should be defined instead of being used loosely -- that there should be a definite line drawn between "expendable" dehydration and dehydration of such a degree that it cuts down on bodily functions. During severe dehydration, water may be drawn from the intracellular compartment of the body, rather than merely from the extracellular.)

Lt. Comdr. McCay asked what the temperatures were during these experiments. Dr. Schwimmer replied that the room temperatures ranged from 69 to 78 degrees F., and the barometric pressures from 29.73" Hg. The relative humidities were 45% to 78%.

Lt. Shelesnyak asked whether salt could not be added to salt-free water. Lt. McDevitt replied that water on the life raft is seldom salt free. Dr. Schwimmer added that the desalinated water was never salt-free, and usually contained at least one gram of salt. He also mentioned that his subjects had experimentally drunk water containing two grams per 800 cc. and considered it "too salty", whereas one gram in 800 cc. was fine. Then the question arose, if one could drink 100 to 200 cc. sea water without particular bodily harm, why not tell the boys to go ahead? The objection to the recommendation of drinking from 100 to 200 cc. sea water was that the boys would probably drink over the 100 to 200 cc and then would be in danger of bodily harm.

Capt. d'Angelo inquired as to whether or not the body temperatures and basal metabolisms of the subjects were measured. Dr. Schwimmer replied that all measured 98.6 and sometimes a little below. The fluctuating measurements of the basal metabolism as measured on a McKesson machine, Dr. Schwimmer attributed perhaps to the nervousness of the subjects.

Dr. Ivy stated that the insensible water loss and total negative water balance varies widely in different individuals and never exactly repeats itself twice in the same individual during the first five days of fasting or low caloric intake. The same thing is true of the basal metabolism rate. For this reason, his laboratory has given up the performence of exact metabolic studies and is conducting simple physiology

studies on rats and monkeys, in which groups of the animals are given food and water at various sub-normal levels and the survival time is determined.

Capt. d'Angelo stated that if a rat or a guinea pig is acutely starved (no food and water) for three to four days there is usually adrenal cortical hypertrophy. If the animal is chronically starved (restricted caloric intake), however, there will be cortical atrophy. This and other evidence, indicates that the endocrine glands may be intimately involved in some of the physiological changes occurring in starvation, and that the changes may be qualitatively, as well as quantitatively, different with different degrees or levels of starvation. It might be worthwhile to pay some attention to hormonal factors in starvation studies. (Dr. Schwimmer stated that his laboratory is running Kemper-Robinson tests for adrenal function and will publish them when the experiments are completed.

Dr. Longenecker: In view of our problem, how much additional water is required in the metabolism of protein?
Dr. Schwimmer: There is almost a quantitative increase in the amount of nitrogenous material appearing in the urine corresponding to the protein fed. We found one thing as regards excretion which is of interest. In none of our experiments did the actual urine volume approach the theoretical minimum as calculated from Dr. Gamble's factor 1.4. None of our subjects was able to concentrate urine much above 1.2 osmols per liter, with an average about 1 osmol per liter.

Dr. Schwimmer (in answer to a question about kidney damage) On all preliminary examinations, every one of the subjects showed normal renal function. As deprivation progressed, however, several of the boys began to spill in their urines quantities of albumin, red cells, white cells, and casts. One subject even exhibited red-blood-cell cast at one time. We felt that such subjects, even though apparently normal on preliminary examinations, probably had diminished renal reserve. Such diminished renal reserve might perhaps be picked up by doing complex renal clearance studies.

Henschel: I have seen only one such case of heat cramps and that resulted probably from a drastic reduction in water intake. The salt intake did not seem to be the primary cause of the cramps.

Physiological Round Table:
(Major Ashe acted as temporary chairman)

Major Ashe:

It is desired to know whether we think that a survival ration should be individually carried, raft carried or rescue equipment carried. He asked for comments.

Major Culmer:

Major Culmer listed the following on the blackboard:

Man plus 1-man life raft)
)Survival
Multiplace raft)
)

Dropped by Rescue Party)Plane

Major Culmer suggested that the survival "ration" in question be considered to be limited to that which can be either carried by the man himself or in his attached 1-man raft accessories.

Lt. Col. Dolan:

We think it should be an all-purpose ration, and should be looked at from an all-purpose point of view, to be carried individually.

Lt. Shelesnyak:

Lt. Shelesnyak suggested that we put it in the raft and have one on the man also.

Major Hatke:

Major Hatke had the experience of being torpedoed in the middle of the night and the first thing the GI's hollered for was a D Ration to take with them. He suggested a good ration in a small can that the GI's could stick in their pockets.

Major Ashe:

The question was asked as to whether anyone thought that the individual man should not carry a ration in his pocket.

Lt. Comdr. McCay:

On an individual-carry ration you have to figure on what other gear the man has to carry.

Major Ashe:

It is now generally agreed among us that there should be a survival ration the individual has immediately available to him. This ration should be all-purpose for land, sea and air. It must be used, as we see it at the moment, in climates that are both hot and cold. The statistical data presented by the Army and Navy Air Forces indicates that under the present rescue system, very near 100% will be picked up in 5 or 6 days. What are the physiological factors? How long should it be designed to make him survive?

Major Scholander:

I would shoot for the maximum. Carrying extra supplies on planes is "gravy".

Major Ashe:

About five men in 10,000 in the Army Air Forces may be exposed to survival in the water and of them 98% will be picked up before two days are gone. If they are in cold climates and are not picked up by that time, they will be dead.

Major Scholander:

The one-man deal is a difficult one. Therefore, the problem should be confined to the one-man carry and the one-man life raft.

Major Bean:

This shows that you have differing situations which an all-purpose ration may not answer. When on the ocean it depends entirely upon whether you are on the warm ocean or the cold ocean. I do not think it is wise to develop an all-purpose ration for the whole job.

Major Ashe pointed out that food has been established as being necessary for any circumstance. He suggested a five-day upper limit.

Major Scholander said that the single place raft is the one which is the problem.

Major Ashe:

Is there any reason for planning for more than five days?

Captain d'Angelo:

Is it a survival ration or a morale ration? A man could starve for a long period of time.

Dr. Ivy:

If I had a 1000 calories and came down in a cold climate, I would eat it quick. If I came down in the tropics, I would not eat any the first day.

Lt. Colonel Kinney:

Col. Kinney proposed a one-day unit. He said that the soldier will take as many as he thinks he is going to need. The Air Forces can provide number expected to be needed.

Major Ashe said that on the one-day basis it would have to be left up to the operational people of the various arms and services to determine how much to put on, to which all agreed. The main point in American Army supply history is that the American soldier must have food similar to food he is used to. Infantry soldiers have mutinied rather than eat food which they do not recognize.

Major Bean agreed. He said that today we cannot give the specifications for it. "We should see if one ration can answer all of the conditions". He proposes that the ration be field tested to find out. Until we find out what the requirements are in given situations, it seemed to him that it is to no purpose to propose detailed specifications.

Dr. Henschel:

From the reports given here it is apparent that food has not been a real factor in survival with the possible exception of in arctic conditions. In cold climates a good survival ration may prolong life sufficiently to increase the probability of rescue provided survival equipment is adequate. To give the largest number of calories per unit weight and volume of ration, the ration should have as high a fat content as possible and still be palatable and acceptable. A fat content of the ration up to 20% by volume would be about the highest one could go.

Lt. Commander Futcher:

Does anybody have any evidence that shows food in arctic conditions would prolong survival?

Major Ashe:

On a 1,000 calorie diet, high protein intake will increase body heat. (Cited OSRD Reports)

Dr. Ivy:

Pointed out that gastro-intestinal disturbances may occur on high fat and high sugar diets. The diet should be relatively high in carbohydrates, should contain not over 15% fat by volume. The question of the amounts of protein has not been definitely settled. The malted milk tablets were placed in the Navy ration because there were favorable reports on the item and the amount allowed would not increase water requirements.

Dr. Ivy believes that more experience on humans will show that protein will not be utilized for tissue building in partial fasting but will be burned.

Dr. Longenecker:

Dr. Longenecker explained that Dr. Ivy meant 15% concentration by volume not calories.

Dr. Ivy:

The level of the concentration of fat by volume in the diet at which the stomach is inhibited has been established to be between 12 and 15%. People who are "sensitive" to fat will show symptoms at levels as low as 5%. He stated that 15% is the top on fat, except when heavy labor is being performed. When the tone of the gastric musculature is high, as when much physical work is being performed, it is more difficult to inhibit the stomach with fat or sugar.

It was suggested that the conference discuss the situation of palatability. Major Butts was in a life boat which carried biscuits as emergency food. Two days later, although he had had no other food, he still did not eat the biscuits.

Major Butts:

"The question of palatability is most necessary. It has been noted that in both simulated tests and under actual survival conditions, where the subjects had no assurance of rescue, food was actually refused. In the former case the present life raft ration was being tested. In the later case the only food was a hard dry biscuit.

"It must be remembered that approximately four hundred cubic inches is the present maximum cubage allowed."

Major Ashe:

If man is not doing anything at all, just lying in the boat, he may use 1800 calories, or if rowing all day, his caloric output may go up to 4500, if he has to row as one man did, 150 miles. The problem, therefore, is to give him some food to burn yet there are difficult space weight limitations. How many calories shall we shoot at?

Dr. Scott:

The amount of good you will get out of food will be proportional to the caloric content. It brings up the point that anyone who is on a survival ration will be in a state of bad nutrition. His physical condition will be going downhill. Dr. Scott stated that it was "bad nutrition" to feed inadequate calories. In the long run you would have to expect the effects of bad nutrition regardless of the composition of the food.

Major Ashe:

Major Ashe said that the data presented indicates we are dealing with a short term proposition. Minnesota tests show that as low as

25% of caloric requirements do not do much harm to manual aptitude in periods even longer than we are anticipating. This does not include the effects of cold, of course.

Dr. Dove:

As far as food acceptance is concerned, we should ask the soldier and put the problem up to him as an experiment. The final decision may have to come from the experiment. We should try to get around the problem of monotony. Food must be acceptable to men and it must be highly preferred. Highly preferred foods do not remain that way if fed to men day after day. He suggested variety in units of the survival ration, and stated that the type of container will be an important factor.

Major Ashe:

The problem of command function and discipline is important.

Dr. Dove:

It would be well to consider the units as building blocks. If there is enough variety you can build it up into a real ration, even though it is of the survival type.

Lt. McDevitt:

Major Wodicka has said from time to time that the D bar has some proponents. The D bar packs a wallop yet if considered as food, it's not so hot.

Major Ashe:

It is agreed (after discussion) to shoot for 750 calories as a minimum, or approximately 25% of the mean predicted requirement. It is also agreed that it is not the function of the conference to specify foods, but only to set known physiological and utilization standards. Acceptability is recommended as a high consideration. What about the salt requirements -- thelowest we can get away with?

Major Bean:

I would be much surprised if salt even became a limiting factor unless water intake was much higher than it would be normally. Most foods, unless exclusively carbohydrate, would provide naturally the amount needed.

Dr. Longenecker:

Twenty-five percent of the total calories could be taken as a working basis.

Major Ashe:

If you are not eating food, inevitably you are using body tissue and therefore you are deriving salt.

Lt. Comdr. Futcher:

It must not be forgotten that on a life raft one will ingest considerable salt in water prepared by Permutit desalting kits or by solar stills.

Major Ashe:

The added salt would be tolerated without difficulty.

Major Bean:

Salt content of a small ration would be thirst provoking and that is an important point. He thinks it would be a good idea to test it out.

Major Ashe:

A minimum of 2.5 grams of salt is agreed upon.

Vitamins were discussed next. Major Ashe said that he knew of no vitamin deficiency which would develop in ten days.

Major Bean:

"Amen!"

Major Ashe:

Therefore, the Laboratory need not worry about vitamins.

(The Navy concurred.)

Dr. Ivy:

Dr. Ivy proposed label information which sells the soldier on the food.

Major Ashe stated that quantity of vitamins was no worry. No worry about iron or calcium. No worry of anemia.

Protein metabolism was discussed next. Major Ashe said that this is a very difficult problem. All the necessary information is not now available. This ration should be made up of carbohydrates, fat and protein in the same proportion as now in the regular Army rations as consumed - Say, 150 grams of fat, 125 of protein and the rest is carbohydrates. Three thousand six hundred and fifty (3650) calories consumed. Fat figures appear to be higher than Navy's. One hundred and ten (110) fat. Is there any objection to quartering these?

Dr. Lepkovsky:

Dr. Lepkovsky said that the protein should be put in in proportion to other ingredients which would permit the protein to be utilized for tissue sparing action.

Dr. Ivy:

For eight hundred cc. of water, the protein is a little high. Major Ashe disagreed.

Discussion resulted in Major Ashe's summary that a minimum of Protein - 30 to 35 grams and Fat, 25 to 30 grams could be taken as minimum requirements.

Stowage conditions were discussed at this time.

Lt. McDevitt:

The Army Air Forces has supplied us with the Life Raft temperatures and it appears that the highest temperatures in planes is upwards of 120° and we are studying now how that temperature fluctuates day by day. The Technical Branch is of the opinion that the fluctuation is quite great and the heat ceiling is detrimental even if it only lasts for about three hours. The lowest limit of temperature is said to be at least minus 65°.

Colonel Isker:

In tropics, the temperature would be as high as 135°.

Lt. McDevitt:

With this temperature range of storage is it assured or can it be assured by the using Services that it will be an indestructible ration or one that would have to be changed periodically, or must we look for a three and a half year storage life as we have had to with the life raft ration?

Major Ashe:

As a supply agency, one must keep these facts in mind.

Lt. McDevitt:

Gripes always land back here.

Colonel Isker:

When the K Ration was developed, it wasn't to be stored longer than 1 year, but it is being used up to two years. I think we should have a pretty stable ration good for at least two years.

Lt. Comdr. Futcher:

I am not sure that one can get a completely satisfactory all-purpose ration and survival for land, sea and for cold and hot survival.

Dr. Lepkovsky:

A good ration will be good under any conditions.

Major Bean:

Pointed out that the food tastes vary in different climates.

Dr. Lepkovsky:

A ration is not good when it is not eaten.

Major Ashe:

Called for comments on packaging.

Mr. Biesel:

Gave the following requirements on the packaging of the ration: (1) water proof, (2) durable, (3) easily opened, (4) rectangular shaped container, because it has been more desirable to the convenience in carrying it.

Lt. McDevitt:

Gave a summary of the meeting up to this point and added, as another requirement to the packaging of the ration, that the package should be resistant to changes in pressure. Discussion by Captain Wilgus and Dr. Lepkovsky regarding caloric intake and utilizing of protein for tissue building.

Lt. McDevitt:

There is a lot of feeling that 800 to 1000 calories a day is a good goal to permit protein utilization.

Major Scholander:

Suggests using K Ration as a guiding principle in development for storing inside the life raft. If a survival ration is wanted, then the "C" Ration is needed.

Lt. McDevitt:

We have good rations for use in rescue work and for providing outside of this one-man raft proposition. These should be, in our opinion, strongly considered. The reaction to the C Ration will probably be better when we get fruit and bread into it.

Major Berryman:

It seems to me that there has been omitted some reference to water balance. Either 800 cc. of water should be available each day, or don't eat if you can't drink.

Lt. McDevitt:

How would this apply to cold weather?

Major Berryman:

In cold weather eat.

Dr. Ivy:

Explained that food only increases the water requirement during ingestion if it is very dry. The amount of protein recommended, 30 grams should not increase the water requirements.

Major Scholander:

We did not drink more than 600 cc. per day of water. In fact we drank only 400 cc.

Lt. McDevitt:

But you weren't sweating. What about a hexamine heat tab?

Mr. Biesel:

Does not work out in wet cold.

Major Ashe:

With a small amount of food, suggest a self-heating can be tried to improve use in cold climates.

Colonel Isker summarized the accomplishments at this meeting:

1. We should look into the idea brought out by Major Culmer to discuss this problem with some of the survivors and send out questionnaires to interview these survivors. Also, obtain information from Wright Field and other agencies.

2. Acceptability should be the first requirement. Dr. Dove spoke of high acceptability. If we know that a ration is acceptable, survivors won't object to it if they have to live on it for 3 or 4 days. When the K Ration was developed it was made up for only short periods, but in this case there won't be the danger of using the ration for weeks and months, therefore it does not have to be as highly acceptable; however it should be palatable, and have some degree of acceptance.

3. Dropping rations to survivors is a different problem. As Captain Carveth brought out, it is very seldom dropped closer than 50 yards, and therefore makes it difficult to reach in the water.

4. Lt. Comdr. McCay touched on an important problem at this time. I agree, we should go into these problems sanely and more thoroughly than we have done during the war. Now that all pressure and hurry is over with, we should go to work with something more concrete and "kick" it around, and in a year or two we should have a ration that will beat any today.

5. Packaging has been a problem throughout the war and as for cellophane sticking to rations, we had the same trouble with the D bar.

6. In order to establish better correlation between the various government agencies, the present OQMG research program aims to make all information for government and civilian organizations available to us.

Lt. Shelesnyak added that military and civilian problems do differ, and there should be a nucleus of military personnel to carry on the military angles of this research.

7. I was fortunate enough to attend a field test in Colorado and feel that a ration of this sort should be thoroughly tested under all conditions which it would be used in the service.

8. Develop an individual all-purpose ration that will take care of the Ground Forces, Air Forces, Navy, Coast Guard, and any other Forces. This ration, in addition to what we have on the board* should be acceptable, stable, and properly packaged for all conditions.

9. Research must be continued to find the proper balance of food to go into this ration.

10. In building this ration we should make use of all technicians, medical officers, nutritionists, engineers, and all technical people. We have found it very difficult to get along without this unit.

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